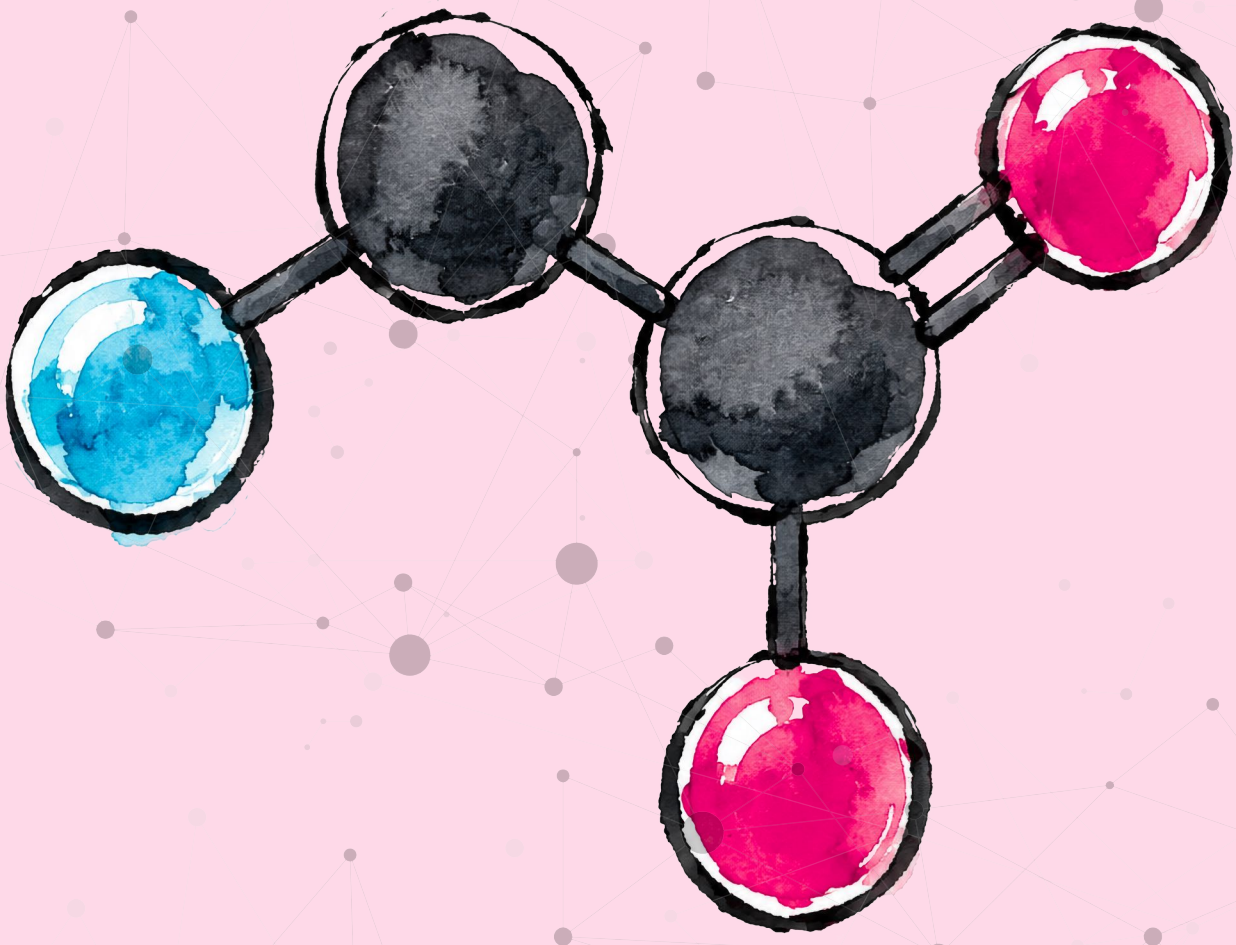
edexcel iAL

A2 CHEMISTRY



Topical Questions

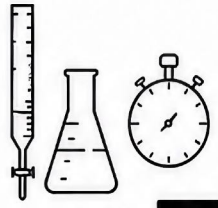
Unit 6

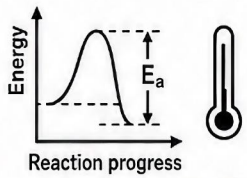
Edexcel IAL Chemistry

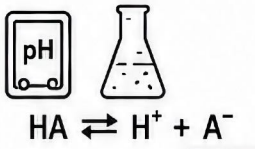
Unit 6: Practical Skills in Chemistry II (WCH16/01) • Questions & Answers by Topic

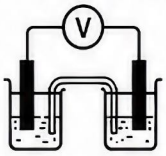
Contents

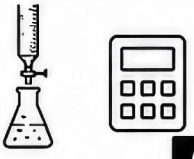
All Unit 6 practical topics in one place.

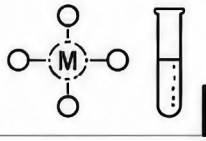


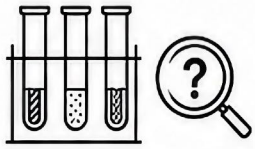


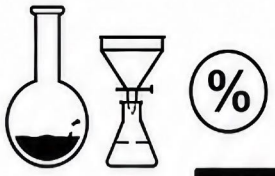


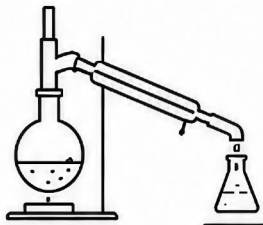


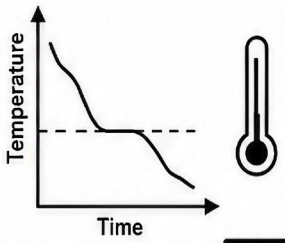












Smart revision. Better results.
Use these topics to focus your study, practise with confidence and tackle Unit 6 like an examiner.

You've got this!
Consistent practice today, success tomorrow.

Edexcel IAL - Solved Past Paper

October 2020 · Unit 6: Practical Skills in Chemistry II (WCH16/01) · Q3

hard medium easy

3 (a)

State · [1 mark]

Students determine the rate equation for $BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \longrightarrow 3Br_2(aq) + 3H_2O(l)$. Phenol solution (10.0 cm^3) with methyl red is mixed with potassium bromide, sulfuric acid and potassium bromate(V); the time t to bleach the indicator is recorded. Two of the hazard warning signs for phenol are shown. State the most important hazard associated with phenol in this experiment and the precaution you would take to reduce the risk, apart from wearing safety goggles and a laboratory coat.

The two hazard signs printed on the paper: corrosive and toxic.

Model answer

✓ Phenol is CORROSIVE, so wear (chemical-resistant) gloves. The risk in this experiment is skin contact while handling the solution – so the matched precaution is gloves, not a fume cupboard.

Mark scheme 1 mark - ONE hazard with its matched precaution

✓ corrosive, and wearing gloves (1)

Accept: 'caustic' for corrosive; 'toxic by skin absorption, so wear gloves'

Do not accept: giving both pairings ('toxic so use a fume cupboard' AND 'corrosive so wear gloves') - the question demands the MOST IMPORTANT hazard

Ignore: 'irritates the skin'; use of a fume cupboard

How to reach full marks

One hazard, one matched precaution. In a dilute aqueous solution handled at the bench, the live risk is contact with skin - corrosive, gloves.

Where marks are lost

Hedging with both hazards and both precautions scores zero, and so does 'flammable' - phenol here is an aqueous solution, not a vapour.

Examiner's insight

A very mixed response: many presumed toxicity or even flammability, and some who chose corrosive still paired it with a fume cupboard - the precaution must match the hazard.

3 (b)

Explain · [2 marks]

Explain the purpose of the phenol in this experiment.

Model answer

✓ Phenol reacts rapidly with the bromine as it forms, removing it from the solution. ✓ Only when ALL the phenol has been used up does free bromine build up and bleach the methyl red - so the colour change marks a FIXED extent of reaction, and t measures how long the reaction takes to make that fixed amount of bromine.

The connection to make

The phenol plays exactly the role the small fixed amount of thiosulfate plays in the iodine clock: a sacrificial scavenger that delays the colour change and turns 1/t into a measure of rate.

Mark scheme 2 marks

- ✓ phenol reacts (rapidly) with the bromine formed in the reaction (1)
- ✓ when all the phenol is used up, the (excess) bromine bleaches the methyl red - a fixed point in the progress of the reaction (1)

Accept: 'phenol removes the bromine'; 'the indicator decolourises when all the phenol has reacted'
Do not accept: 'phenol is a solvent'
Ignore: the white precipitate of 2,4,6-tribromophenol

How to reach full marks

Two ideas in sequence: phenol soaks up the bromine as it forms; its exhaustion is the clock. Step 5 of the procedure says the colour is bleached 'by excess bromine' - a deliberate hint; use it.

Where marks are lost

Stopping at 'phenol reacts with bromine'. The second mark is the clock idea - the colour change happens at a fixed, known extent of reaction. And 'phenol is the solvent' is explicitly refused: the state symbols show an aqueous reaction.

Examiner's insight

Most candidates could not progress beyond phenol reacting with bromine, despite the hint in Step 5 - the clock idea was the hard-won second mark.

3 (c)

Suggest · [1 mark]

Suggest a way of making the disappearance of the methyl red colour easier to see.

Model answer

✓ Stand the boiling tube against a WHITE background (a white card or tile) - the moment the red is bleached shows far more sharply against white.

Mark scheme 1 mark

- ✓ use a white card / white background (1)

Accept: any position of the white card
Do not accept: a cross drawn on white card; a colorimeter
Ignore: adding more indicator / increasing its concentration

How to reach full marks

Plain white background - nothing more. You are watching a colour VANISH, so contrast is everything.

Where marks are lost

The disappearing cross belongs to the sulfur clock (a precipitate hiding a mark); importing it here is refused. So is a colorimeter - this is a visual clock experiment.

Examiner's insight

Most candidates scored this, though the role of the white card was often left vague - say the tube is viewed against it.

3 (d)(i)

State · [1 mark]

The student's results are shown in the table. State why the total volume of the mixture is kept constant (at 40.0 cm^3, topped up with distilled water).

The student's results (as printed)

Run	BrO_3^-(aq) / cm^3	Br^-(aq) / cm^3	H_2SO_4(aq) / cm^3	H_2O(l) / cm^3	time t / s	1/t / s^{-1}
1	15.0	5.0	10.0	0.0	40	0.025
2	12.0	5.0	10.0	3.0	51	0.020
3	10.0	5.0	10.0	5.0	62	0.016
4	8.0	5.0	10.0	7.0	74	0.014
5	6.0	5.0	10.0	9.0	100	0.010
6	4.0	5.0	10.0	11.0	154	0.0065

Model answer

✓ So that the volume of bromate(V) solution added is directly PROPORTIONAL to its concentration in the mixture – doubling the volume then genuinely doubles the concentration, and volume can stand in for concentration on the graph.

Mark scheme 1 mark

✓ so the volume of BrO_3^-(aq) is proportional to its concentration (1)

Accept: 'equal to' / 'equivalent to' for proportional

Ignore: 'fair test'

How to reach full marks

The answer is one word deep: PROPORTIONAL. Constant total volume is what licenses plotting volume instead of concentration.

Where marks are lost

Generalised answers - 'to make it a fair test', 'to control variables' - describe the intent without the chemistry and score nothing.

Examiner's insight

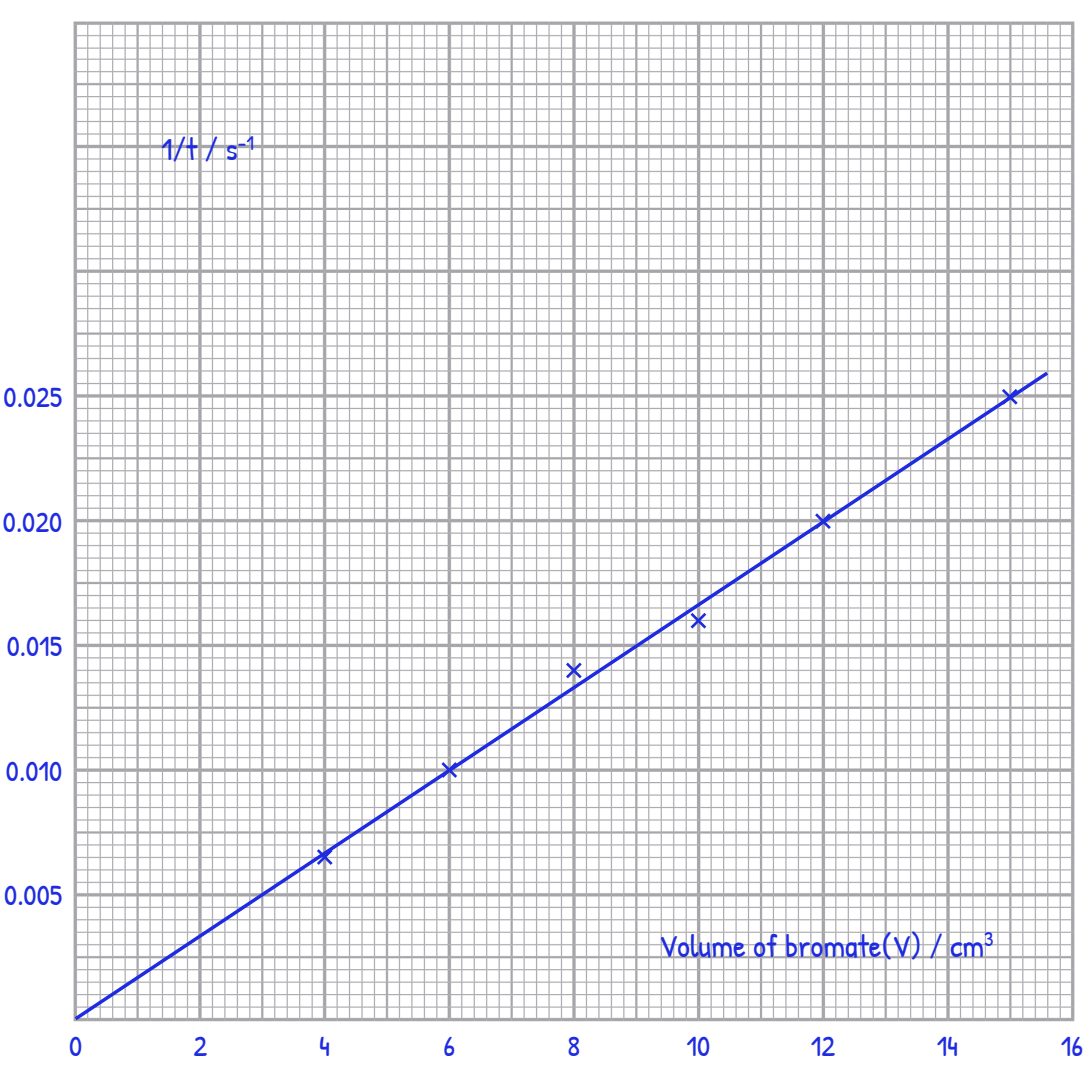
A good number saw the significance, but generalised fair-test answers were everywhere and scored no credit.

3 (d)(ii)

Plot · [3 marks]

Plot a graph of reciprocal time (1/t) against volume of bromate(V) solution.

The completed graph



Scales chosen so every point lands on a gridline: 1 cm^3 = 5 small squares, 0.0005 = 1 small square. The ruled best-fit line passes through the origin and through points 1, 2, 5 and 6; point 3 sits fractionally below it and point 4 fractionally above.

The three marks

✓ Sensible LINEAR scales with 1/t on the vertical axis and the plotted points covering at least half the grid in each direction. ✓ Both axes labelled WITH units: 1/t / s^{-1} and volume of bromate(V) / cm^3. ✓ All six points plotted correctly and a single ruled best-fit line drawn through the origin.

Mark scheme 3 marks

- ✓ suitable choice of scale and correct choice of axes (1)
- ✓ axes labelled, with units (1)
- ✓ all six points plotted correctly and best-fit line (through the origin) (1)

Accept: plotting and best-fit line judged by impression; the points (with the origin, if included) must cover at least 50 per cent of the grid in both directions

Do not accept: a non-linear scale - only the labelling mark then remains available

Ignore: punctuation slips in the units, e.g. (cm3) instead of / cm^3

How to reach full marks

Rate-like quantity (1/t) UP the side, volume along the bottom. Pick scales that put the data on gridlines - 2 cm^3 per large square and 0.005 per large square do it here - then rule ONE straight line through the origin, balancing the scatter.

Where marks are lost

The examiners' list: 1/t plotted on the x-axis, units missing from labels, and scales that cramp the points into half the grid. Plotting errors were rarer than axis errors.

Examiner's insight

The graph produced very mixed responses - many marks went to quite basic errors: the rate term on the wrong axis, incomplete labels, missing units.

3 (d)(iii)

State · [1 mark]

State the order of reaction with respect to bromate(V) ions. Justify your answer.

Model answer

✓ FIRST order with respect to bromate(V) – because the graph of 1/t (which is proportional to rate) against volume (proportional to concentration) is a STRAIGHT LINE THROUGH THE ORIGIN.

Mark scheme 1 mark - order AND justification

- ✓ first order, because the 1/t against volume graph is a straight line through the origin (1)

Accept: first order justified by 'as the volume (concentration) doubles, the rate doubles' or 'as the volume doubles, the time halves'

Ignore: 'rate increases as concentration increases'; a bare 'rate is proportional to concentration'

How to reach full marks

State the order, then justify it FROM THIS GRAPH: straight line, through the origin. Or quote the data - volume doubled (6.0 to 12.0), 1/t doubled (0.010 to 0.020).

Where marks are lost

'Rate increases with concentration' is true of every positive order and scores nothing. The origin matters: a straight line that misses the origin is not first order.

Examiner's insight

Most candidates knew it was first order, but generalisations replaced the data far too often - justify from the line you drew.

3 (d)(iv)

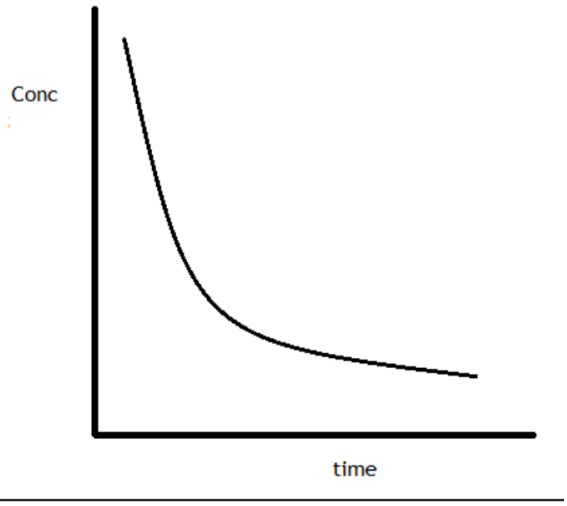
Suggest · [1 mark]

Reciprocal time (1/t) is used as a measure of rate in this experiment. Suggest the

assumption on which this depends, referring to the shape of a typical graph of reactant concentration against time.

Model answer

✓ It assumes the methyl red is bleached EARLY in the reaction, while the concentration–time curve is still effectively LINEAR – over that early stretch the gradient (the rate) is constant, so the average rate up to the colour change, which is what 1/t measures, equals the initial rate.



The mark scheme's sketch: concentration against time falls steeply and is near-straight at the start - the clock must stop within that straight region.

Mark scheme 1 mark

- ✓ the indicator is bleached early, when the concentration-time graph is (almost) linear, so the gradient (rate) over the timed interval is constant (1)

Accept: the same idea shown on a sketch graph; 'assumes the rate is constant for a particular run'

Do not accept: just 'concentration is proportional to time'

How to reach full marks

The clock assumption in one line: the measured interval sits inside the initial straight part of the concentration-time curve, so average rate = initial rate. A quick sketch with the straight region marked earns the same mark.

Where marks are lost

Restating '1/t is the rate' without the assumption, or the refused shortcut 'concentration is proportional to time' - the point is that the curve is only APPROXIMATELY linear, and only at the start.

Examiner's insight

Very few candidates had any idea of the theoretical basis of this near-universal technique - though there were some excellent explanations among them.

3 (d)(v)

Explain · [2 marks]

Another student accidentally measured 8.5 cm^3 of potassium bromate(V) rather than 8.0 cm^3 in Run 4. Explain whether or not this portion of potassium bromate(V) should be

discarded.

Model answer

✓ It need NOT be discarded: the results are plotted on a graph, so the exact volume does not matter provided its value is KNOWN – the point is simply plotted at 8.5 cm^3 instead of 8.0 cm^3. ✓ But the volume of water must be adjusted from 7.0 cm^3 to 6.5 cm^3, so the total volume stays at 40.0 cm^3.

Mark scheme 2 marks

- ✓ need not be discarded - the data are plotted, so the actual (known) volume can be used (1)
- ✓ the water must change from 7.0 to 6.5 cm^3 (total kept at 40 cm^3) (1)

Accept: 'need not be discarded if the volume is known'; 'the total volume of solution must still be kept at 40 cm^3'; if no other mark is scored, 'discard it, because the total volume will have changed' earns 1

Ignore: references to experimental uncertainty

How to reach full marks

A graph forgives an off-target volume - it just becomes a different x-value - provided you correct the water so the total stays 40.0 cm^3. Both halves are needed for both marks.

Where marks are lost

Candidates who kept the 8.5 cm^3 portion usually forgot the matching water adjustment; candidates who discarded it could still salvage one mark only via the total-volume argument.

Examiner's insight

Most marks here came from the one-mark fallback (discard, because the total volume changes); those who saw the graph point often failed to adjust the water.

3 (e)(i)

Give · [1 mark]

All volume measurements are made using a 50 cm^3 burette. Give a reason why the potassium bromate(V) solution is first measured into a separate boiling tube rather than directly into the reaction mixture.

Model answer

✓ A burette delivers the solution too SLOWLY – run in directly, the reaction would already be underway during the addition, so the start time (and hence t) would be wrong. Tipping the pre-measured portion in from a boiling tube makes mixing effectively instantaneous.

Mark scheme 1 mark

- ✓ the burette transfers the liquid too slowly, so the start time would be inaccurate (1)

Accept: the reverse argument; 'the reaction would start before all the $KBrO_3$ had been added'; 'the reaction starts immediately, so the time is difficult to measure'

How to reach full marks

Tie the slowness of the burette to the TIMING - the whole experiment stands on knowing when t = 0.

Where marks are lost

Comparing the burette and boiling tube as measuring instruments - precision is not the issue; the delivery speed is.

Examiner's insight

Well understood, though often unclearly expressed; weaker answers drifted into the burette's superiority as a measuring device.

3 (e)(ii)

Give · [2 marks]

Give two reasons why Run 1 has the lowest uncertainty in the volume measurements.

Model answer

✓ Run 1 uses the LARGEST volume of bromate(V) (15.0 cm^3), and percentage uncertainty = (apparatus uncertainty / volume measured) x 100 - so the largest volume carries the smallest percentage uncertainty. ✓ Run 1 adds NO water, so that volume measurement - and its uncertainty - is eliminated altogether: only three volumes are measured instead of four.

Mark scheme 2 marks

- ✓ 15.0 cm^3 is the largest volume, so the lowest percentage uncertainty (1)
- ✓ no water is used, so that measurement uncertainty is eliminated (1)

Accept: just 'it is the largest volume'; just 'no water added'; 'only three volumes are measured'

Ignore: references to measurement error

How to reach full marks

Two separate ideas: biggest single volume (percentage argument) and fewest volumes measured (the water term vanishes). Give both - the question says two reasons.

Where marks are lost

Talking about the burette's apparatus uncertainty in the abstract, or claiming Run 1 is 'more accurate because fewer impurities' - the uncertainty here is arithmetic, not contamination.

Examiner's insight

Most candidates scored at least one mark, with some excellent percentage-uncertainty explanations; the word 'uncertainty' tempted many into generic apparatus talk.

3 (f)

State · [2 marks]

State the changes that you would make to the procedure to obtain the data needed to determine the overall rate equation for the reaction between bromide and bromate(V) ions in acid conditions.

Model answer

✓ Repeat the whole series of runs varying the volume (concentration) of $Br^-(aq)$, and then again varying the volume of $H^+(aq)$ (the sulfuric acid) – the orders with respect to BOTH remaining species are still unknown. ✓ In each series change only that ONE volume, keeping all the other volumes constant and topping up with distilled water so the total stays 40.0 cm^3.

Mark scheme 2 marks

- ✓ repeat the experiment for (various concentrations of) Br^- ions and then for H^+ ions (1)
- ✓ vary the volume of each in turn, keeping all other volumes constant (1)

Accept: H_2SO_4 for H^+ ions; 'concentration' for volume; if no other mark is scored, repeating with the volume of Br^- varied and BrO_3^- kept constant earns 1

How to reach full marks

The rate equation needs the order with respect to all THREE species - bromate(V) is done, so two more series: vary Br^- alone, then vary H^+ alone, everything else fixed.

Where marks are lost

Forgetting the H^+ series entirely - very few candidates remembered that the acid's order must also be determined - and vague 'change the concentrations' answers that never say ONE AT A TIME.

Examiner's insight

Many scored one mark, but the one-variable-at-a-time idea was poorly expressed and the hydrogen-ion series was almost universally overlooked.

Revise from your notes

- The clock method - principle, procedure and reasoning 9.1 9B.1-9B.6

to 2 significant figures like the printed ones.

Mark scheme 1 mark - both values, to 2 significant figures

✓ 1/t = 0.021 (for 48 s) and 0.016 (for 64 s) (1)

Accept: values matching the printed pattern of 2 significant figures

How to reach full marks

Match the table's own style: the printed values have 2 significant figures, so give 0.021 and 0.016 - not 0.02083 or a truncated 0.015.

Where marks are lost

Rounding slips: 0.020 for 1/48 (it is 0.0208, which rounds UP) or 0.015 for 1/64 (0.015625 rounds up to 0.016).

Examiner's insight

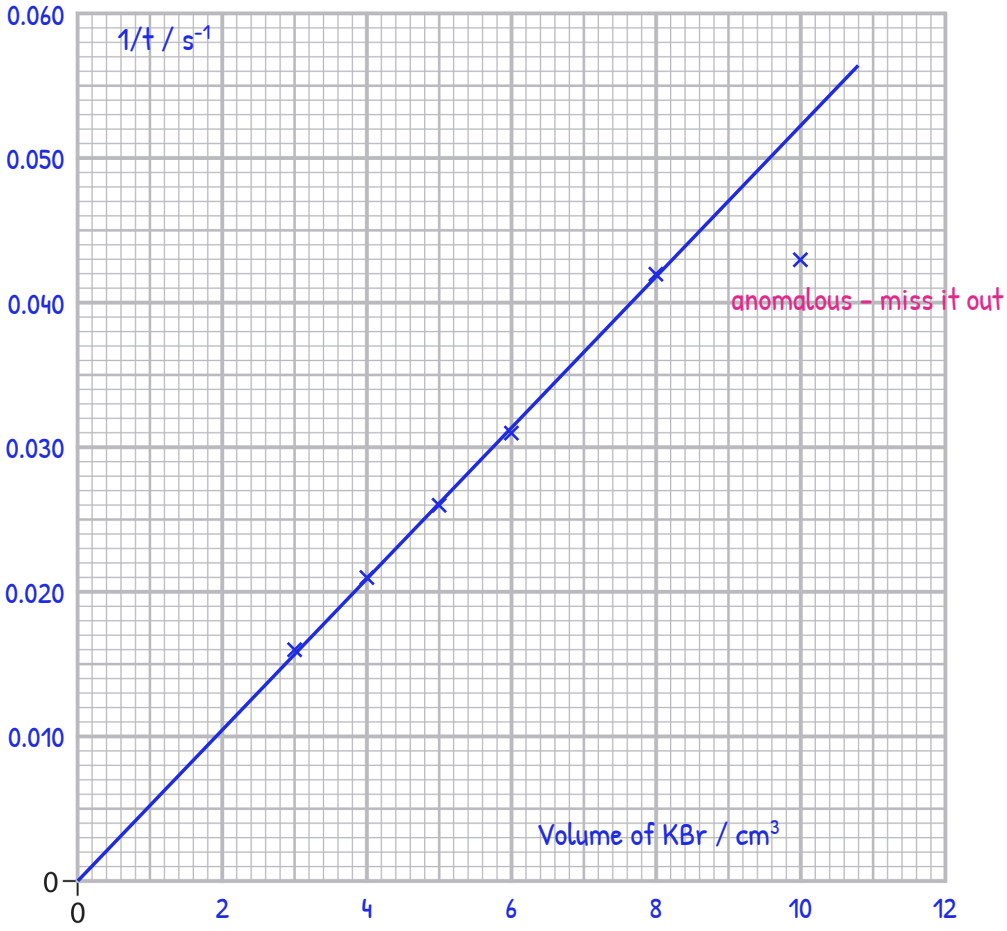
The overwhelming majority scored this mark.

3 (c)(ii)

Plot · [3 marks]

Plot a graph of 1/t against the volume of KBr. Include a line of best fit.

The completed graph



Scales: 1 cm^3 = 5 small squares and 0.001 = 1 small square, so every point sits on a gridline intersection (coverage 50 of 60 squares across, 43 of 60 up). The ruled least-squares line passes through the origin and the five consistent points; the 10.0 cm^3 point - the run done at 18 degrees C instead of 22 - is plotted but deliberately missed.

The three marks

✓ Axes the right way round – 1/t vertical, volume of KBr horizontal – labelled WITH units and on scales that spread the points over at least half the grid each way. ✓ All six points plotted correctly (within one small square), marked with clear crosses. ✓ A single ruled straight line of best fit passing THROUGH THE ORIGIN and MISSING the anomalous point at 10.0 cm^3.

Mark scheme 3 marks

- ✓ axes labelled correctly with units and a suitable scale (1)
- ✓ all points plotted correctly (1)
- ✓ straight best-fit line through the origin, missing the anomalous point at 10 cm^3 (1)

Accept: an error margin of one small square on plotting; TE on the 1/t values from (c)(i); a line that would pass through the origin if extrapolated; TE on wrongly plotted points provided the line goes through the origin - and the points must cover at least 50 per cent of the grid in both directions

Do not accept: the first mark if the variables are plotted the wrong way round; the third mark if the axes do not start at (0, 0)

How to reach full marks

Rate-like quantity (1/t) UP the side, volume along the bottom, units on both labels. Choose scales that land the data on gridlines - 1 cm^3 = 5 small squares and 0.001 = 1 small square here - then rule ONE straight line through the origin and let it miss the 10.0 cm^3 point.

Where marks are lost

Transposed axes (kills the first mark), axes not starting at (0, 0) (kills the line mark), and above all a best-fit line CURVED so it collects the anomalous point - the 18 degrees C run does not belong on a 22 degrees C line.

Examiner's insight

Usually completed to a high standard; the common errors were transposing the axes, bending the best-fit line to include the anomalous point, and plotting points so faintly they vanished under the line.

3 (c)(iii)

State · [1 mark]

State why the volume of KBr is proportional to the concentration of bromide ions in the reaction mixture.

Model answer

✓ Because the TOTAL volume of the reaction mixture is the same for every run – the KBr is always topped up with water to 10.0 cm^3 (40.0 cm^3 once mixed), so the volume of KBr added is the only thing that changes, and doubling it genuinely doubles $[Br^-]$ in the mixture.

Mark scheme 1 mark

- ✓ the total volume (of the mixture) remains the same for each run (1)

Accept: 'the total is always 40 cm^3' (or 10 cm^3 in beaker Q); 'the volume of KBr is the only variable'

Do not accept: a bare 'concentration is proportional to volume' - that restates the question

Ignore: 'moles are proportional to volume'

How to reach full marks

The mark is for the REASON: constant total volume. That is the whole point of the water column in the table - it licenses plotting volume in place of concentration.

Where marks are lost

Circular answers. Restating that concentration is proportional to volume, without the constant-total-volume reason, is explicitly refused.

Examiner's insight

Only a minority appreciated the significance of keeping the volume constant, and some quite elaborate explanations were offered for this simple procedure.

3 (c)(iv)

State · [1 mark]

State the order of reaction with respect to bromide ions, using your graph.

Model answer

✓ FIRST order – the graph of 1/t (proportional to rate) against volume of KBr (proportional to $[Br^-]$) is a straight line through the origin, so rate is directly proportional to $[Br^-]$.

Mark scheme 1 mark

✓ first order (1)

Accept: '1st' or '1' for first

Ignore: explanations - but there is no TE from an incorrect graph in (c)(ii)

How to reach full marks

Straight line through the origin = first order. State the order plainly; the justification costs nothing but earns nothing here.

Where marks are lost

Reading an order off a curved line drawn through the anomaly in (c)(ii) - there is no transferred error onto this part, so the graph mistake can cost twice.

Examiner's insight

The order was usually deduced correctly.

3 (d)

Deduce · [1 mark]

After investigating the effect of the concentration of bromate(V) ions and of hydrogen ions, the student obtained the graphs shown. Deduce the rate equation for the reaction, using these data and your answer to (c)(iv).

Edexcel IAL - Solved Past Paper

October 2022 · Unit 6: Practical Skills in Chemistry II (WCH16/01) · Q4

hard medium easy

4 (a)

Name · [1 mark]

Ethyl butanoate reacts with water: $CH_3CH_2CH_2COOCH_2CH_3 + H_2O \longrightarrow CH_3CH_2CH_2COOH + CH_3CH_2OH$. 50 cm^3 of the ester is heated under reflux with a very large excess of water; every 30 minutes a sample of known volume is removed and titrated with aqueous sodium hydroxide, until three consecutive titres are the same. Name the apparatus which is most suitable to remove the samples from the reaction mixture.

Model answer

✓ A (volumetric / graduated / bulb) PIPETTE - used with a pipette filler, since the mixture is hot.

Mark scheme 1 mark

✓ (volumetric / bulb / graduated) pipette (1)

Accept: a syringe

Do not accept: a dropping or teat pipette; a burette; a measuring cylinder; a gas syringe

How to reach full marks

'A sample of KNOWN VOLUME', removed repeatedly and accurately, means a pipette - the standard sampling tool of every titrimetric rates practical.

Where marks are lost

Teat pipettes and measuring cylinders - neither delivers an accurate fixed volume - and the burette, whose job is delivering the titrant, not withdrawing a sample.

Examiner's insight

Suggestions such as a burette, a measuring cylinder and even forceps revealed a lack of understanding of the procedure for this kinetics investigation.

4 (b)(i)

Give · [1 mark]

The student plotted $V_{final} - V_t$ on the y-axis against time, where V_{final} is the titre at 4.5 hours and V_t is the titre at time t. Give a reason why $V_{final} - V_t$ is plotted on the y-axis, rather than the concentration of sodium hydroxide solution for each titre.

Model answer

✓ $V_{final} - V_t$ is directly PROPORTIONAL to the concentration of the ETHYL BUTANOATE remaining - the subtraction turns a product measure (the acid titrated) into a reactant measure, with no extra calculation.

Mark scheme 1 mark - the substance must be named

✓ $V_{final} - V_t$ is proportional to [ethyl butanoate] (1)

Accept: V_{final} - V_t is proportional to [reactant]; the MS also allows the flip-side phrasing 'a product is being monitored (rather than a reactant)' - i.e. the raw titre V_t follows the acid PRODUCT, and the subtraction converts it into a reactant measure

Ignore: just 'volume is proportional to concentration'

How to reach full marks

Say WHICH concentration: V_{final} - V_t tracks the ester. V_t alone follows the acid produced; subtracting it from V_{final} follows the reactant instead - exactly what a rate graph wants.

Where marks are lost

'Volume is proportional to concentration' with no substance named - not enough - and naming the wrong substance (the alcohol) sank otherwise close answers.

Examiner's insight

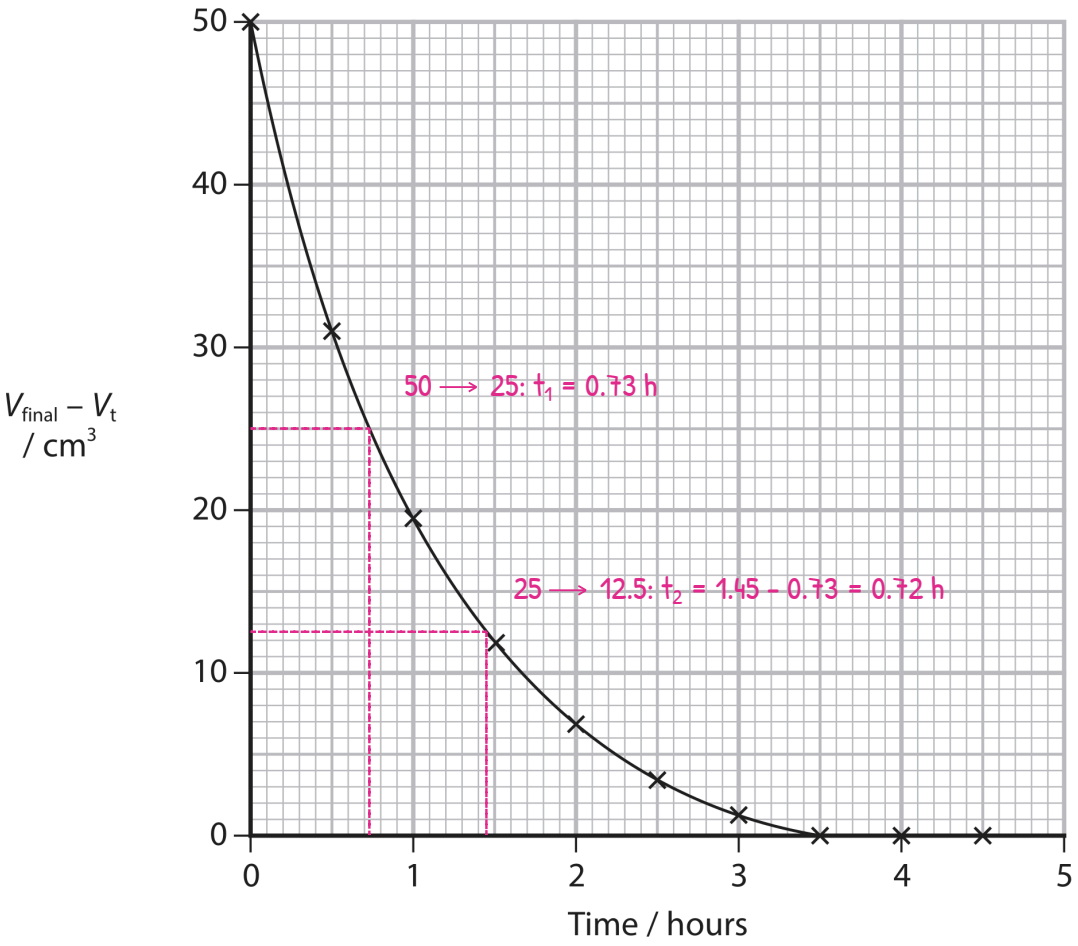
Very rarely awarded: it was not enough to state that the change in volume was proportional to concentration - which substance had to be stated, and some responses incorrectly chose the alcohol rather than the ester.

4 (b)(ii)

Explain · [2 marks]

Explain how the data collected indicates first order kinetics. Show your working on the graph.

Half-life construction on the printed graph



Successive half-lives read off the printed curve: 50 ⟶ 25 cm^3 at 0.73 h, then 25 ⟶ 12.5 cm^3 at 1.45 h. The mark scheme accepts half-lives anywhere in 0.65-0.75 h; its own worked example quotes 0.70 and 1.40.

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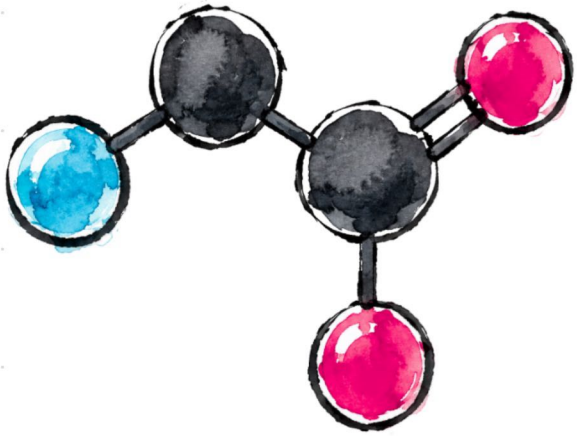

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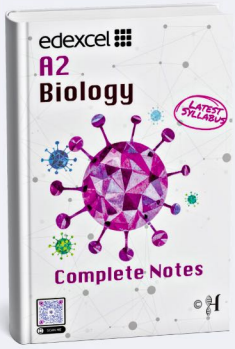

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